TWO CASES OF TUMOR OF THE SPINAL CORD.[1]

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The two cases of tumor of the spinal cord which are here presented in this paper differ considerably in course and duration, and especially in their anatomical character. The first case was one of endothelioma of the dura of the cord.

Case I. The patient entered the Home for Incurables, on April 16, 1885, and was under the care of Dr. J. W Courtney, whom I have to thank for permission to use the notes of the case. At the date of entrance the records of the hospital say that the patient, a single woman, twenty-two years of age, was born in Charlestown. Her father died of lead poisoning, and her mother of phthisis. She had had the ordinary diseases of childhood, and since she was seventeen years of age had done the work of a domestic servant. In June, 1884, she began to lose the use of the legs. In October of that year she could still walk with assistance, but at the time of her entrance to the hospital she had absolutely no power in the legs, while the arms were unaffected. Her temperature upon admission was 99.0° F. and her pulse 100. There was some constipation and incontinence of urine. The note says, "She is very comfortable." From the first of May to September of that year there was more or less pain during micturition, and also in the abdomen. The note in September, 1887, is that the patient was suffering from symptoms of cystitis and urethritis, and that she complained mostly of violent spasmodic and sudden contractions in her limbs. In November it is noted that there were beginning flexor contractures in the legs, that the patient was much emaciated, and that her mind was somewhat affected. In the following May it is noted that the patient's mental upset had culminated in an acute maniacal outburst. She broke all mechanical restraint, tore out her finger and toe nails, and attempted several times to strangle herself. She was sent to the McLean Hospital for the Insane, and later returned to the Home for Incurables. From December

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[1] Read at the twenty-sixth annual meeting of the American Neurological Association at Washington, D. C., May 1-3, 1900.

3 to April 1, 1888, there was decubitus of the right nates, and also on the left, which slowly improved. August 1, 1892, the note says, "Have straightened legs at most every visit, using all the strength I possessed, causing no pain, as she has no sensation in the legs." In April, 1893, it is noted that the patient was more hysterical than she had been in a long time, and not only depressed, but excitable, and that there was constant incontinence of urine. From this time on there are no entries in the records, but Dr. Courtney states that the patient was bedridden and extremely anemic. The cranial nerves were not affected, and although the pupils were pretty constantly dilated, they reacted to light, and upon accommodating. The upper extremities were free and the lower ones contractured and atrophied to a marked degree. The reflexes were not obtainable on account of the contractures. Sensibility in all forms was lost to a level on the trunk at about the mid-dorsal region. The function of the vesical and rectal sphincters was completely abolished. Decubitus was present. Exitus from exhaustion occurred on April 19, 1898. Autopsy by Dr. R. M. Pearce, on April 19, 1898. Body of woman about thirty-six years old, poorly nourished, and poorly developed. Decubitus over sacrum and right trochanter. Contractures of both lower limbs. Abdomen showed nothing abnormal on inspection. Pleural cavities normal. Pericardium normal. Valves and cavities of heart normal. Lungs normal. Spleen dark red in color and firm. Capsule smooth. On section; dark red in color and the Malpighian bodies not visible. Pulp not increased. Gastro-intestinal tract normal. Liver dark red in color and capsule smooth. On section, markings indistinct, and substance firm. Gall bladder normal. Kidneys irregular and nodular in shape; capsule peels leaving a rough, granular, uneven surface. In places there are rather deep depressions, which, however, do not appear to be scarred areas. On section the cortex is somewhat diminished, and the glomeruli appear as opaque points. Substance firm. Adrenals normal. Aorta normal. The bladder contains a considerable amount of whitish opaque fluid. Uterus, tubes and ovaries normal. Brain with its membranes normal. Middle ear normal. Spinal column. In the middorsal region of the vertebral column there is a projecting knuckle formed by the spinous processes of two vertebræ. Upon removing the cord there is found below the cervical enlargement, and at the level of the spine of the scapula, a granular reddish swelling of the dura, about 2.5 cm. in length. This tumor appears to be meningeal, but has almost completely replaced the cord beneath it. Below this point the

cord is considerably atrophied. There is no lesion of the cord opposite the vertebral knuckle.

Microscopical examination: The cord and tumor were hardened in formalin. Sections were made from the tumor, and at various levels of the cord, and stained with hematoxylin and eosin; methylene blue and eosin; and with Weigert's stain for myelin sheaths. Sections from the tumor about the cord show a tissue which varies considerably in various parts. In general it is composed of a mass of cells with large oval vesicular nuclei, rather closely packed together, with unstained cell protoplasm, and with no regular arrangement. In this mass of cells are numerous round bodies, made up of concentric rings, which stain homogeneously, but vary in color from a pinkish blue to a deep blue. About some of these round bodies can be seen two or three quite separate rings in which can be clearly made out the elongated nuclei of endothelial cells, such as are seen in the walls of blood vessels. Many of these corpora amylacea have been calcified. In places the tumor is made up chiefly of these bodies, with more or less connective tissue, and only in places an irregular mass of cells with large nuclei spoken of above. Here and there in the tumor are blood vessels, which appear normal. These are usually small. In a section taken from a slightly lower level, the relations of the tumor can be made out more exactly. It lies in the dura, and at this point only partially surrounds the cord in a concentric mass. The dura is much thickened by increase of connective tissue, and is divided by the tumor mass, which is surrounded by the thickened dura, as by a capsule. At this level, in addition to the calcified corpora amylacea, there are in the tumor mass itself, at its border near the thickened, surrounding dura, three small masses of bone, which show indistinct lamination, and lacunæ, which are more rounded than those seen in normal bone. Occasionally canaliculi can be made out running a short distance from the lacunæ. The bone contains a few marrow spaces in which are blood vessels, and a slight amount of loose, edematous connective tissue. At this level the pia is much thickened by increase of connective tissue. Some of the blood vessels of the pia show marked thickening of the media. The dorsal and ventral nerve roots at this level appear practically normal. The cord at this level shows only a few scattered fibers at the periphery which have retained their myelin sheaths. The cord in general at this level shows no signs of the normal structure. It is made up of a very dense meshwork of neuroglia fibers, which become less dense at the periphery, and in the gray matter of the cord.

Rarely a nerve cell can be made out, but those that are seen are rounded or flask shaped and show no signs of processes, or at most but a single one, and show either no signs of nucleus and nucleolus, or indistinctly staining ones. The only remains of the normal nerve fibers of the cord are a few scattered fibers at the periphery, and a rather larger number of fibers, grouped together at the periphery of the posterior columns, which have retained their myelin sheaths. Elsewhere the cord is completely transformed by the growth of neuroglia fibers, though the shape of the gray matter can still be made out from the surrounding part of the cord because of its lesser density. The nerve roots appear fairly normal. Section of the cord a little above the point of greatest compression, stained by Weigert's method, show the cord considerably lessened in size, and a very marked degeneration of the median part of the posterior columns. In this area practically no nerve fibers can be seen which have retained the sheaths. There is also a diffuse, but well marked, degeneration in the direct cerebellar tracts, and at the periphery of the cord throughout the lateral border, and also along the anterior fissure. The atrophy is very marked in the direct cerebellar tracts and less so in the other portions, where some normal fibers are seen among the degenerated fibers. Immediately below the point of greatest compression, the cord being still small in size and shrunken, the sections stained by Weigert's method show the usual descending degenerations. The cord is small and there is a well-marked indentation just anterior to the point of exit of the posterior nerve roots. There is a very marked degeneration of the fibers of the lateral and anterior pyramidal tracts, and a moderate diffuse degeneration at the periphery of the cord in its anterior and lateral parts, and a very slight diffuse degeneration throughout the anterior ground bundle. The nerve roots are normal The degeneration at the periphery of the cord is no longer seen at the lower part of the dorsal cord, though the degeneration of the motor tracts, both lateral and anterior, is well marked here, as also that of the lateral pyramidal tract in the lumbar cord, after the anterior tract has ended.

Anatomical Diagnosis: Decubitus; chronic diffuse nephritis; chronic cystitis; contractures of lower limbs; endothelioma of the dura, with calcification, and bone formation; compression of the cord with secondary atrophy and sclerosis of the cord; ascending degeneration of the posterior, and direct cerebellar tracts, and descending degeneration of the pyramidal tracts, with diffuse degeneration of the tract of Gowers' and anterior ground bundle, and at the periphery of the cord for a short distance above and below the point of compression.

To resume, we have in this case to do with a young woman who gradually became paraplegic during the course of ten months. At the time of admission to the hospital the sensory and motor paralysis, and the paralysis of the sphincters seems to have been complete, and was certainly so at a later period, and from that time on she seems to have had no pain, an unusual thing in tumors affecting the spinal cord, where pain and tenderness of the spinal column are apt to be early and fairly constant symptoms. Gradually very marked contractures developed, and the patient remained in much the same condition for a period of thirteen years, except for an outbreak of mental trouble with excitement, from which she made a good recovery. Death finally came to end the scene, probably caused by exhaustion induced by the bed-sores, the diffuse nephritis, and the chronic cystitis. The autopsy showed these conditions, as well as a tumor of the dura which proved to be an endothelioma which had produced a practically complete destruction of the nervous elements of the cord at the point of greatest compression with increase of neuroglia tissue and the usual ascending and descending degeneration of the various tracts of the cord.

Schlesinger[2] states that endotheliomata of the cord, usually proceed from the dura, and are often multiple. They constitute one of the rarer forms of tumors affecting the spinal cord.

Mader[3] has recently reported a case which was fatal in twenty-nine days from the time that the symptoms were first noticed, and twenty-five days after entrance in the hospital. In this case there was found an endothelioma of the dura which the author thinks was affected by an acute swelling by which the rapidity of the disease was explained.

Orlowsky[4] in the Society of Neuropathologists and Alienists at Moscow, at the meeting October 22, 1897, reported a case in a fourteen year old girl, where the disease began with mild pain in the back, and progressive weakness of the legs. Three months after the beginning of the symptoms she was admitted to the hospital, and at that time there was complete paralysis of the legs, with flaccid muscles, and atrophy, absent knee-jerks, lively Achilles tendon reflex, anesthesia over the whole of the lower extremities, except the posterior surface of the thighs, and the outer side of the lower legs, to a point four fingers breadth above the navel in front, and to the level of the ninth dorsal spine behind, with a slightly hyperesthetic zone above this anesthetic one, and with retention of urine and feces. In the course of the disease the anesthesia increased, paresthesiæ and intention tremor of the hands came on, followed by anesthesia of the ulnar region of the arms, and paresis of the arms, with marked wasting of the legs. The patient died fourteen months after the onset from septicemia and disturbance of respiration. The autopsy showed an endothelioma of the pia, which had destroyed the cord. The growth was vascular, and contained obliterated, and hyaline degenerated, and calcified vessels. It also showed much connective tissue, which was also hyaline. In addition there was a gliosis in the posterior columns, with cavities, which were not lined with epithelium, and were not connected with the central canal, nor with the tumor. There was marked softening of the medulla, and some small metastases of sarcoma in the pia of the brain and cerebellum. Orlowsky ascribes the syringomyelia and gliosis to stasis produced by the tumor, and thinks the case favorable to the theory of Langhans and Kronthal of the origin of syringomyelia from stasis, but thinks that the central canal need not be involved, as they thought necessary.

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[2] Schlesinger, H., "Beiträge für Klinik der Rückensmarks- und Wirbeltumoren." Jena., 1898, p. 37.

[3] Mader, J., "Perivasculäres Sarcom der Dura Mater spinalis. Acute Schwellung derselben mit rapid sich entwickelnden Compressions-erscheinungen. Paraplegie. Grangraen. Cystitis. Tod." Weiner méd. Blätter, 1898, XXI, 249.

[4] Orlowsky, Neurolog. Centralbl., 1898, XVII, 92.

Wersiloff[5], at another meeting of the same society, on January 30, 1898, reported a case in which the duration of the disease was three and a half months. It began rather suddenly with symptoms of a spastic spinal paralysis of the left extremities, and diminished sensation on the right side

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[5] Wersiloff, Neurolog. Centralbl., 1898, XVII, 563.

of the body and the right lower extremity. A few weeks later there was a complete paralysis of the right extremities with increased tendon and skin reflexes. Throughout the course of the disease there was no sign of compression of the posterior nerve roots. The autopsy showed a somewhat similar condition to that found in the case we are considering. The tumor was an angio-sarcoma psammomatosum, arising from the dura at the level of the second cervical segment, and compressed the cord markedly from the left side. Lancereaux[6] published a case of a woman who gradually became paraplegic with strong flexor contractures of the legs, loss of power over the sphincters, and considerable impairment, but not absolute loss of sensibility, where the course of the disease was extended over six years, and there was found a tumor growing from the inner surface of the dura, and compressing the cord in the mid-dorsal region, so that it was softened, and dark in color. The tumor, which was 3 cm. long, was a sarcoma in which the cells were arranged in concentric groups, the centers of which had undergone calcification.

Troitzy[7] reports a case of five years' duration, in which pain was the first symptom, and where there was a flaccid paralysis of the legs, with absent knee-jerk and tendo Achillis reflex, paralysis of the bladder and diminished sensation. The autopsy showed a tumor growing from the inner side of the dura at the level of the third lumbar segment, which was 3.5 cm. by 2.0 cm. in size. Microscopically it was composed of endothelial cells, arranged in bands and groups, in the center of which there could often be made out a lumen. There was no calcification. Clarke[8] reported a case in a man twenty-eight years of age. It began with weakness of the arms and legs, but only a dull aching sensation in the shoulders. Later there was paresis of the

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[6] Lancereaux, Quoted by Gowers, "Diseases of the Nervous System." Phil., 1892 2d ed., i., 545.

[7] Troitzy, S., "Ein Beitrag zur Kenntniss der Endotheliome der Pachymeninx spinalis." Prag. med. Woch., 1893, XVIII, 603.

[8] Clarke, J. M., "On endothelioma of the spinal dura mater; with a case in which an operation was performed." Brain, London, 1895, XVIII, 256.

legs and arms, with some wasting in the small muscles of the hand. The knee-jerks were increased, and there was ankle-clonus. The patient became completely paralyzed in ten days. Sensation was lost in the arms and body, but was present over the legs. The patient then left the hospital to return two years later desiring an operation. This was performed, and the tumor removed, but the patient died that night, apparently from shock, as he lost much blood during the operation. The tumor extended from the fifth cervical to the first dorsal segments. The author calls it an "endothelioma or psammoma, more properly the former, as it contained calcareous granules."

Drs. Alexandroff and Minor[9] at the meeting of the Society of Neuropathologists and Alienists at Moscow, on February 23, 1896, reported a case of compression of the cord at the level of the fourth and fifth cervical vertebræ, in which an operation was performed, but the patient died of pneumonia. At the autopsy an endothelioma of the vertebræ and dura was found.

Aside from these cases Schlesinger[10] speaks of one published by Eppinger,[11] in which the growth proceeded from the epithelioid cells of the subarachnoid space, and of another of Dionisi[12] proceeding from the dura. Schlesinger's own cases are those numbered 37 and 38.[13] The first was in a woman twenty-seven years of age. The first symptoms were pains, slight sensitiveness of the spine to pressure, with stiffness of the spine. One year later weakness of the legs appeared, and six months later still there was paraplegia with loss of the tendon reflexes, and with severe pains and bladder disturbances, and disturbances of sensation. The autopsy showed an endothelioma of the dura in the lumbar region. composed of spindle-cells, and with concretions similar to brain sand. In the second case Schlesinger gives no clinical history. At the autopsy there was found at the level of the third and fourth dorsal vertebræ a tumor springing from the arachnoid, which compressed the cord so that its continuity appeared completely broken. No details of the microscopical examination are given, but the tumor is called an endothelioma.

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[9] Alexandroff and Minor, Neurolog. Centralbl., 1896, XV, 1048.

[10] *loc. cit.*, p. 38.

[11] Eppinger, "Endothelioma der Pia spinalis." Vierteljahresschift für prakt. Heilkunde, CXXV, 171.

[12] Dionisi, "Tumore del middollo spinale." Società Lancisiana degli Opedali di Roma, 1892.

[13] *loc. cit.*, p. 171-173.

Dexler[14] reports two cases of tumors in dogs, the second of which was an extra-dural tumor, 2.5 cm. long, which microscopically was an endothelial sarcoma, and had produced compression of the cord with characteristic symptoms.

In the consideration of the endotheliomata of the cord, however, there seems to be considerable uncertainty whether psammomata are to be classed as a form of tumor separate from the endotheliomata or not. Schlesinger[15] says that a sharp differentiation of these tumors from the endotheliomata apparently cannot be drawn, and proceeds to describe the psammoma as composed of small spindle cells, which are fused into concentric circles, and says that the proper nature of these formations, which are characteristic of psammomata, is still in dispute, and that it is not certain whether they are an epithelial product or, as seems more probable, altered vessels. He then states that he has collected fourteen cases from the literature, and adds four from his own material. The one of Lancereaux, those of Blondel, Berger, and Oustaniol were inaccessible, but a study of the others, Schlesinger's own cases, numbers 39, 40, 41 and 42 in his series, in general reported very briefly, and Ernst's cases of psammoma of the cerebral meninges, seems to show that the psammoma as described have varied in character. In Wilks'[16] case there is no description sufficient to determine the nature of the tumor, and Hutchinson,[17] though describing his case as a psammoma, says it strongly suggests an endothelioma, in

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[14] Dexler, H.; "Zwei Fälle von Tumoren der Rückensmarkshäute." Monatshefte für prakt. Thierheilkunde, VII. Ref. in Neurolog. Centralbl., 1896, XV, 852.

[15] *loc. cit.*, p. 38.

[16] Wilks, "Tumor of the spinal cord." Transactions Pathological Soc., London, 1855, VII, 37.

[17] Hutchinson, J. W., "Psammoma of the spinal cord." Transactions Pathological Soc., London, 1882, XXXIII, 23.

which partial calcification had occurred. Lediard's[18] case, classed by Schlesinger as a psammoma, he himself calls an endothelioma of the pia. Cayley[19] speaks of the concentric arrangement of the cells, and of calcification, and Whipham's[20] description is very similar. Steudener[21] gives a very insufficient description of the appearance of the tumor, but calls it a psammoma, as Pal[22] does his case. In the Verein für Wissenschaftliche Heilkunde at Königsberg, Lichtheim[23] reported two cases operated upon, one of which died of meningitis, while the other recovered, and could walk again, and in both instances he states that the tumor was a psammoma, but no description of the appearances was given. Bailey[24] also reports a case of psammoma of the dura, at the level of the seventh and eighth dorsal segments, which pressed upon the posterior columns, but had run its course without symptoms, except the loss of the knee-jerk, and without pain, the tumor being found at the autopsy. He reports in the same paper a case of syphilitic affection of the meninges, which also had produced no pain, and concludes that the presence or absence of pain, in cases of tumor affecting the spinal cord, is due more to the location of the tumor than to its particular variety. Ernst[25] in his paper certainly shows that these growths are not epithelial in origin or character, but probably proceed from the blood vessels, or lymph spaces, and are properly endothelial, and a study of the cases reported seems to show that while it is possible that under the psammomata there have been included some cases of sarcoma, or other growths with calcification, in the majority of cases we have to do with endotheliomata proceeding from the blood vessels, or lymph spaces, and varying in the amount of irregularly arranged cell masses, those where this has predominated having been usually classed among the endotheliomata, while cases in which the concentrically arranged cell masses were numerous, and particularly where there has been calcification, have been classed as psammomata. Gowers in the case of Lancereaux, referred to above as an endothelioma, calls it a sarcoma in which the cells were arranged in concentric groups, the centers of which had undergone calcification. It seems to me that these growths are certainly endothelial in origin, and cases, such as the one we have just presented, from the mixture of the tissues which apparently vary so much in structure, seem to show that these two classes of tumor are in reality but one. The presence of calcification in the tumor is not unusual, but the presence of true bone as in this case is much more rare, certainly in tumors, though more common following inflammatory processes. In this case we had, too, certain of the characteristics of psammomata, in the slow growth of the tumor and the long duration of the disease, with the marked compression of the cord, present for so long a time, without extension into the cord itself, and as in general such cases are well adapted for operative interference, we may feel that this case was one in which an early operation might have produced a brilliant result.

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[18] Lediard, H. A., "Tumour of dura mater, pressing upon the cord in the cervical region." Transactions Pathological Soc., London, 1882, XXXIII, 25.

[19] Cayley, W., "Tumour pressing on the spinal cord." Transactions Pathological, Soc., London, 1865, XVI, 21.

[20] Whipham, T., "Tumor of the spinal dura mater, resembling psammoma, pressing upon the cord." Transactions Pathological Soc., London, 1873, XXIV, 15.

[21] Steudener, F., "Zur Kenntniss der Sandgeschwülste." Virch, Arch. f. path. Anat. u. Phys., 1870, l, 222.

[22] Pal, J., "Ein Fall von Rückensmarks-compression." Wiener klin. Woch., 1892, V, 350.

[23] Deutsche med. Woch., 1891, XVII, 1386.

[24] Bailey, P., "Report of two cases of tumor of the spinal cord, unaccompanied with severe pain." JOURNAL OF NERVOUS AND MENTAL DISEASE, 1896, XXIII, 171.

[25] Ernst, P., "Ueber Psammome." Beiträge z. path. Anat. u. z. allgem. Path., 1891-2, XI, 234.

The second case I have to report occurred in a boy, six years of age, who came to the Department for Diseases of the Nervous System, at the Boston City Hospital, on May 31, 1899. His family and previous history threw no light upon the case. The account given at that time was that the symptoms were of two weeks' duration, and had followed a fall from a small cart while it was in motion, a distance of less than two feet, the boy striking first on the right elbow and then on the right shoulder and back. The next day he complained of pain in the elbow, and two days later the mother noticed that he could not open the hand to take a biscuit. Then he began to complain of intense pain in the right shoulder and neck, especially at night, and the mother noticed that the head was held fixed and not moved normally. The mother also stated that while she was pregnant with this child she saw a man with an amputated left arm, which, at the time, made her feel very badly. When the child was born the left forearm was absent. Physical examination at the time of application showed a pale, not very well developed boy, with a congenital absence of the left forearm from a point about two inches below the elbow joint. The radius and ulna could be felt for a distance of about two inches. There was marked rigidity of the neck from spasm of the muscles, and the head was held inclined toward the right shoulder, with the chin rotated to the left and elevated. Passive movement of the chin to the left was possible to a slight extent, but not to the right. There was no marked tenderness of the spine to pressure, nor pain on pressure upon the head. There was weakness of the right arm and the fingers could be flexed and extended, but very slightly. Supination and pronation of the forearm was possible, but weak. The arm could be abducted to an angle of 120 degrees. There was no tenderness to pressure along the nerve trunks. Sensation was intact. The electrical reaction of the affected muscles was normal. The pupils were equal and reacted to light and upon accommodating. The heart was normal. The symptoms continued and the paresis of the right arm increased, so that it could not be moved, and on June 19 it was stated that he had been dragging the right foot in walking for about a week. Examination on that day showed the right knee-jerk increased, but no ankle-clonus. The strength was markedly diminished in the right leg, but the leg could be lifted from the bed and rotated and the foot inverted and everted; in fact, there seemed to be no definite paralysis, but only a diffuse paresis of this extremity. The head was held in the same position as at the first examination, and there was considerable spasm and rigidity of the muscles of the neck, but no deformity of the spine. Passive motion remained the same as before. The child was unable to move the right arm or hand, except that there was slight power of flexion of the forefinger. The right shoulder could be elevated. The right hand was somewhat swollen. There was very slight quantitative change in the reaction of the muscles of the right arm to the faradic current. The pupils were equal and reacted normally. Sensation was intact. The right cremasteric reflex was increased. The urine was negative. The same day the patient was admitted to the hospital on the service of Dr. Cushing, to whom I am indebted for permission to use the notes taken in the hospital. The patient was put to bed with an extension weight of five pounds. On June 24 it was noted that there was still some muscular spasm, especially in the right scaleni. The power of the right arm remained the same, but the right leg was apparently normal. On June 26 it was noted that the right patellar reflex and the right cremasteric reflex were less than at entrance. On June 28 it is noted that the muscular spasm in the neck was diminishing. On July 1 the note is that the paralysis of the right arm continued and through all this time it is repeatedly stated that the child was comfortable, or "as comfortable as could be expected." The temperature during his stay in the hospital varied somewhat, usually above 99.0° F. and going as high as 100.2° F. The pulse varied between ninety and one hundred. On July 4 the note reads that the temperature the previous night was 101.4° F.; pulse 120; that he ate as well as usual, had no cough; that the glands on the right side of the neck were enlarged and there was marked swelling back of the left ear and above the base of the mastoid, which was apparently not tender. The examination of the chest was negative; no abnormal signs were found. About twenty or twenty-five minutes before death the child complained of severe pain in the back of the neck, which became steadily worse. The extension apparatus was removed and the pillow taken from under the child's head. He became cyanotic, respiratory movements of the chest being scarcely perceptible. The cyanosis increased and the child became unconscious, but without struggling. A loud systolic murmur was heard over the cardiac area, but the pulse was regular and full. Subcutaneous injections of ether and strychnia were given and artificial respiration was kept up for twenty minutes. There was discharge of considerable mucus from the mouth. The head was lowered and the feet raised. The pulse gradually failed and death which ensued was apparently due to failure of respiration.

Autopsy, July 4, 1899. Two and a half hours after death. Body 111 cm. long. Well built and fairly nourished. No decomposition and no marked lividity. Abdomen rather prominent. In the precordial region there is an area of cutaneous congestion, the size of a silver dollar. There is a congenital absence of the left forearm below the upper third. Pupils equal and moderately dilated. The peritoneal, pleural and pericardial cavities contain but the normal trace of fluid and their linings are normal. Diaphragm on the left side stands at the fifth rib and on the right side at the fourth interspace. Heart, weight 70 gms. Heart is normal save for patches of chronic pericarditis. Measurements: Tricuspid value, 8 cm. Pulmonary valve, 4.5 cm. Mitral valve, 7 cm. Aortic valve, 4.5 cm. Left ventricle, 8 mm. Right ventricle, 4 mm. Lungs weigh 230 gms. and are edematous, but otherwise normal. Spleen weight, 35 gms.; normal. Liver weight, 600 gms.; normal. Kidneys, combined weight, 150 gms. They are slightly congested and the glomeruli are a little prominent. Brain weight, 1,500 gms., normal in appearance. The spinal cord presents the chief lesion. Section of the cord in the first cervical segment discloses at this level a hemorrhage into the gray matter, with apparently but little extension into the white columns. The ventral and dorsal cornua are equally affected and of a dark brownish-red color and slightly lessened consistency. The normal markings are absent and the cord appears translucent and grayish in color. Section at the junction of the middle and lower thirds of the medulla appears normal. The hemorrhage extends down somewhat into the cervical enlargement. On opening the dura a large subarachnoid clot is seen extending from the level of the seventh cervical segment to that of the fifth thoracic segment. This clot is chiefly confined to the left dorso-lateral aspect of the cord and produces a distinct local bulging not adherent to the dura. The posterior root fibers are involved on both sides and the point of greatest bulging is in the region of the second thoracic segment.

After hardening in formalin, sections were made across the cord at frequent intervals and the following appearances were noted: The cord throughout the cervical portion is much and diffusely enlarged. Section at the first cervical segment shows the cord of a grayish, translucent color, while the gray matter is the seat of a hemorrhage, dark brown in color, which is fairly sharply limited to this area, extending apparently but very little, if any, into the white matter. At a slightly lower level, about the third cervical segment, the cord shows the same grayish, translucent appearance, but more especially in the region of the right dorsal horn, where the surface on section bulges decidedly above the level of the rest of the section. This gelatinous growth takes up the whole of the right portion of the cord throughout the next two or three lower segments, showing in places a brownish discoloration as if from hemorrhage, while occasionally small brownish areas are seen in the dorsal part of the cord. A little lower the center of the growth has a decidedly brownish color, the translucent grayish color being evident more especially at the borders. Still lower, at the lower part of the cervical enlargement, the hemorrhage is larger and occupies the center of the cord, extending dorsally and broadening, in a general way occupying the portions of the section which normally contain the gray substance and the posterior columns. There is also a considerable sub-pial hemorrhage at this level, chiefly at the posterior part, involving both dorsal roots, which extends down a distance of about 2.0 cm. into the upper thoracic cord. The hemorrhage is about 3 mm. in thickness and lower down involves the left dorsal side more than the right. Here in the upper thoracic region there is quite a large hemorrhage into the gray matter of the cord 3 mm. in diameter, occupying the region about the central canal. This continues downward for about 2.0 cm., where it is again larger and involves the ventral and dorsal horns of the gray matter and the region about the central canal. This hemorrhage in the right dorsal horn extends downward a distance of about 2.0 cm. Below this the cord on section appears normal macroscopically.

Microscopical examination: Sections of the cord were made at various levels, and stained with hematoxylin and eosin; hematoxylin followed by picric acid, and acid fuchsin; by Weigert's method for myelin sheaths; and by Mallory's phosphotungstic acid-hematoxylin, and neuroglia stains. Sections from about the level of the third cervical segment show a marked thickening of the dura by increase of connective tissue. The pia shows no marked changes. The ventral and dorsal nerve roots show no changes. The substance of the cord shows almost no trace of the normal structures, but is composed of a cellular tissue, rich in blood vessels. This tissue is composed of cells, with oval vesicular rather small nuclei, with but little cell protoplasm, which show no regular arrangement. In places the nuclei are smaller and more homogeneous in appearance. No mitoses and no giant cells are to be found. Sections stained for neuroglia fibers show their presence throughout the new growth; in places they are quite numerous, passing in a fine network between the cells and over them, and in other places but few are seen. Here and there in various sections are small areas, made up entirely of a dense meshwork of neuroglia fibers, with almost no cell nuclei to be seen. Some of these areas of neuroglia meshwork lie about the blood vessels. The central canal of the cord can be made out in some of the sections of the cord, but in others no traces of it can be seen. Rarely a nerve cell, shrunken and homogeneous in appearance, can be made out. At the periphery are occasionally small areas, which contain myelin sheaths, which appear fairly normal. No differentiation between the white and gray matter of the cord can be made out, as the whole of the center of the cord is taken up by the tumor mass described. There are quite numerous small hemorrhages throughout the section. At a point lower down the section of the cord shows practically no trace of tumor formation, but at the right side of the cord the pia is densely infiltrated with cells resembling lymphoid cells. These are closely packed together and show no definite arrangement. The infiltration extends into the cord at the point of exit of the dorsal nerve roots, which are seen, fairly normal in appearance, outside of the pia. This infiltration of the cord quickly diminishes, but there is a moderate increase of nuclei in the whole of the posterior horn upon this right side and also about the central canal. At the part of the cord where the infiltration extends into the pia there is a large hemorrhage, and another one, more diffuse, is seen near and posterior to the central canal, and extends back into the left dorsal horn. The cord for the rest appears fairly normal, except that upon the left side there are but very few nerve cells in the anterior horn, though those seen appear normal. These nerve cells are limited to the ventral border of the ventral horn. Still lower the sections show a small area to the right of the central canal, and slightly posterior to it, which is occupied by a fairly loose mass of lymphoid cells, similar to the infiltration described. Posterior to this and posterior to the central canal, extending into the gray matter of both dorsal horns, but more especially upon the right side, is an irregular area of hemorrhage, with small hemorrhages radiating from it and surrounding it. A little below this, in the upper dorsal region of the cord, the sections show nearly the whole central part of the cord destroyed by a diffuse and large hemorrhage, which is rather greater upon the right side of the cord than upon the left side, and leaves but little of the normal structures of the cord. The periphery appears normal, and near the borders of the hemorrhage there are occasional nerve cells, most of which appear fairly normal. Sections from the upper dorsal region, a little lower than this point, show a hemorrhage into the right dorsal horn, completely destroying it up to its root, but not extending into the white substance of the cord. There is great dilatation of blood vessels of the ventral cornua also, but no hemorrhages. Sections from this level, stained by Weigert's method for myelin sheaths, show a moderate diffuse degeneration of nerve sheaths, at the periphery of the lateral and anterior tracts, and of the lateral pyramidal tracts, slightly more marked on the right side than on the left. In other respects the cord appears normal, and also the pia, and nerve roots. Sections from the lower dorsal region show only a moderate diffuse degeneration of nerve sheaths in the borders of the lateral and anterior tracts, and in the lateral pyramidal tracts, rather more marked on the right side. Nothing else abnormal is seen.

Sections from the lumbar region show only slight degeneration in the lateral pyramidal tracts to about the same extent on the two sides.

Anatomical diagnosis: Glioma of the cervical portion of the spinal cord; hemorrhage into the tumor; hemorrhage into the spinal cord; secondary degeneration of the pyramidal tracts.

To resume, a boy of six years, after a trifling injury, developed two days later a weakness of the right hand and arm, with pain in the shoulder and with rotation of the head to the left, where it was held by muscular spasm. At this time there was weakness of the arm with retained electrical reactions, and no sensory changes, at least no marked changes. At this time a diagnosis was made of injury of the nerve roots either from the results of the accident or from disease of the vertebral arches. Later there was marked paralysis of the arm, with slight quantitative electrical changes and paresis of the leg upon the same side, with increased tendon reflexes. Fifteen days after this condition was noted the child suddenly died with symptoms of interference with the respiration, about seven weeks only after the first symptoms had been noticed, and five weeks after he had first come under observation. The autopsy showed a glioma of the whole of the cervical enlargement of the cord, into which hemorrhage had taken place, together with hemorrhage into the cervical and upper dorsal cord.

The case is unusual in the sudden termination by hemorrhage into the tumor, which is much more common in cerebral tumors than in those of the cord, though the gliomata of the cord are usually rich in blood vessels, and often show a brownish or reddish discoloration from the presence of small hemorrhages. In Mader's[26] case, spoken of above, death was also sudden, and he ascribed it to an acute edema of the tumor, which was of the dura. Saenger[27] reports a case of glioma which involved the whole of the lumbar region of the cord from the lower dorsal region to the conus, in which

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[26] *loc. cit.*

[27] "Ein intramedullären Rückensmarks-tumor, Gliom." Münch. med. Woch., 1898, XLV, 978.

there was considerable improvement from the symptoms, but the patient died suddenly. Nonne[28] at the same meeting reported a case of spindle cell intramedullary tumor which extended from the upper cervical cord to the tenth dorsal segment, with total destruction of the cord in the cervical region, where death ensued with bulbar symptoms of disturbance of respiration and heart action. In this case the symptom first noticed was a weakness of the legs, with slight pains and diminished sensation, while later the paralysis of the legs became flaccid, and weakness of the upper extremities came on, accompanied by atrophy and quantitative diminution of the electrical irritability of the paralyzed muscles, and at the last, difficulty in swallowing, paresis of the left abducens, and choked disk. In this case there was a cavity in the part of the tumor which was in the cervical region and the fatal termination may have followed an increase of pressure within this cavity. Fraenkel[29] in his first case reports a gliosarcoma of the cervical region, in which the symptoms began as in this case, with weakness in the arm, and where the duration was short, only one and a half months.

Schlesinger,[30] from 135 cases of tumor from the Vienna hospital, found 20 intramedullary ones, and from 125 intramedullary tumors, collected from the literature and his own cases, he again found 20 of these to be gliomata. He states that glioma of the cord is more common in the cervical or lumbar parts of the cord than in the thoracic portion, while the reverse is true of the extramedullary tumors, which more frequently affect the thoracic part of the cord.

Our case was one in which there can be no doubt that there was present in the cord a true tumor formation, and not the condition described by Schultze, Schlesinger, and especially by Hoffmann, to which the name of gliosis has been given, and this both because of the very nearly complete replacement of the normal structures of the cord in those places where the tumor was most developed and because of its limitation to comparatively a small portion of the cord, as well as the character of the new growth itself.

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[28] Münch. med. Woch., 1898, XLV, 978.

[29] Fraenkel, A., "Zur Lehre von der Geschwülsten der Rückensmarkshäute." Deutsche med. Woch., 1898, XXIV, 442, 457 and 476.

[30] *loc. cit.*, p. 7.

There is also in this case an apparent connection between a slight trauma and the development of the symptoms, which led us astray in the diagnosis. This connection of trauma with tumor of the cord or its membranes, however, has been often noticed, and trauma has been adduced as a cause of the development of new growths. Schlesinger[31] states that a review of the cases in the literature would in some instances allow the inference of the causal relation of trauma to the neoplasm, but that in other cases symptoms had existed previously in greater or less degree and the injury seems only to have acted as an accelerating cause, and, moreover, that in most of these cases we have to do with syringomyelia without tumor formation; that is, cases in which variations of pressure in the cerebro-spinal fluid could act with most effect. Schlesinger, however, concludes that in nearly all the more important groups of neoplasm of the cord and its envelopes, trauma in at least a portion of the cases seems to form an important etiological factor, either in the development of the new growth or in the hastening of the growth of an already existing one. However, in looking over the examples he cites in support of this view, one is forced to the conclusion that this statement is more evidently true when we have to do rather with growths proceeding from the vertebræ, or with the infectious granulomata, where a slight injury may determine the point of origin of the new growth, than with cases of glioma. Certainly it seems to me that our case can hardly be interpreted as affording support to any such theory, in view of the rapid course from the first appearance of symptoms and the marked extent of the tumor development, which seems too great to have taken place within the seven weeks which elapsed between the first symptoms and the death of the patient. I should be much more inclined to ascribe the first onset of symptoms in this case to a small hemorrhage into the tumor, perhaps produced by the fall, similar to the large hemorrhage found at the autopsy, which was probably the immediate cause of death.

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[31] *loc. cit.*, p. 101.

In this case it was exceedingly difficult to judge of the pathological condition causing the symptoms, which were practically root symptoms only, in spite of the fact that the tumor was intramedullary. Information which might have been obtained from the presence of bilateral paralysis was unattainable on account of the congenital absence of the left forearm, while sensory changes were slight throughout the course of the disease, and were certainly absent when the patient first came under observation, and it was only later in the course of the disease that paresis of the right leg showed that the pyramidal tract was involved; so that practically all the differential points which Starr gives[32] for distinguishing an intramedullary growth were absent in this case. These points are: the presence of Brown-Séquard paralysis before paraplegia; early and marked atrophy and reaction of degeneration; early trophic symptoms and bedsores; and the development of analgesia prior to anesthesia. However, the unfortunate lack of any late careful examination of the sensation precludes us from affirming positively that none of these things were present. In particular, Brown-Séquard paralysis may have been present and so have been a precursor of the paraplegia which we may presume would have developed later. Therefore it would be unwarranted to interpret this case as militating against the value of these indications, inasmuch as the early termination of the case prevented the development of the symptoms which in all probability would have given us some more definite clue to the nature and seat of the process with which we had to do, than it was possible to get up to the time of the sudden, and, I might almost say, premature death of the patient.

Any remarks on the nature and origin of gliomata are foreign to the scope of this paper, but it is worth while to note the early age at which the case occurred, though one of Schlesinger's cases was in a child of five years, but this was the only instance among the cases he tabulated in which glioma of the cord occurred under ten years, while the greatest number of cases occurred between the ages of twenty and thirty, and a search through the more recent literature has not revealed reports of any further cases in young children.

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[32] Starr, M. A., Am. Journ. Med. Sciences, Phila., 1895, CIX, 613.